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ABSTRACT

After 2 years of promoting more integration of academic and vocational curriculums, the Southern Regional Education Board identified 15 educational practices that may raise the basic competencies of vocational students: (1) positive practices can be collected and implemented; (2) vocational completers from pilot sites requiring competency tests have performed better than expected in reading and mathematics; (3) students learn significantly more competencies in some schools than in others; (4) expectations affect performance; (5) students had higher reading scores in sites where teachers required them to read for learning; (6) students have higher mathematics scores if they take higher-level courses and apply the skills; (7) students have higher science scores if they take laboratory science courses and if learning progresses from concrete to abstract; (8) the courses students choose are more important in advancing their achievement than the number of credits they accrue in a given field; (9) students learn more when vocational teachers stress academics; (10) at least one-half of students in vocational education say too little is expected of them; (11) higher achieving pilot sites have more students pursuing a coherent and rigorous sequence of vocational and academic courses; (12) many vocational students can master higher-level concepts when they are taught through applications; (13) consensus about the purpose of vocational education should be reached; (14) closing the academic-vocational gap requires communication between teachers; and (15) vocational teachers should spend more time reinforcing reading and writing skills. (KC)

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Improving the Communications, Mathematics, and Science Competencies of Students Enrolled in Vocational Courses

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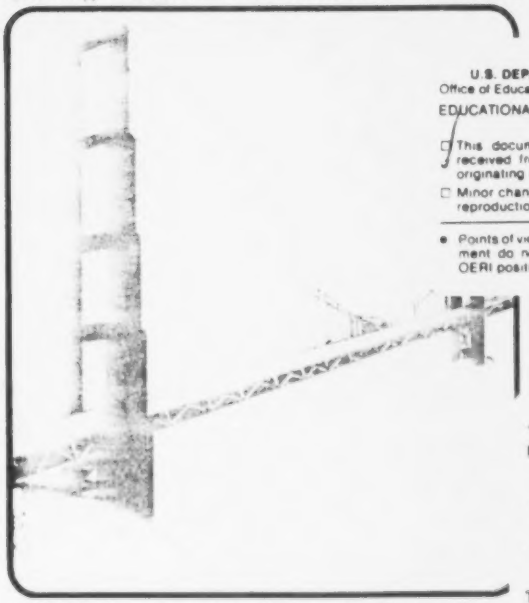

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SREB-State Vocational Education Consortium

WHAT HAVE WE LEARNED?

Update on the SREB State-Vocational Education Consortium

Gene Bottoms
Director, SREB-State Vocational Education Consortium

Less than two years ago, 150 individuals traveled to Atlanta to attend the First Annual SREB-State Vocational Education Consortium's Staff Development Conference—the beginning of an initiative to improve the communications, mathematics, and science competencies of students pursuing vocational studies. Closing the gap between vocational and academic education is part of a larger effort of the Southern Regional Education Board to help its member states gain national and international educational superiority by focusing on 12 educational goals for the year 2000.

The Consortium's goal is to add purpose and rigor to the experiences of those students who pursue vocational studies at the secondary level by improving the quality of both vocational and academic instruction—more specifically, by significantly raising the communications, mathematics, and science competencies of these students.

Before sharing what we have learned about practices that will aid in achieving the Consortium goal, let me briefly make three comments about the project in general.

First, the need for closing the gap between vocational and academic instruction is essential because the requirements for the workplace are rising. Workers of the future must possess higher levels of skills and knowledge in the areas of communications, mathematics, science, technical knowledge, and cognitive skills in order to continue to learn and adapt in a changing work environment.

Second, the idea of linking and improving vocational and academic education is based on the belief that significant improvement in the basic competencies can be achieved by: emphasizing academic concepts through vocational instruction; scheduling more vocational students into higher-level English, mathematics, and science courses; increasing the emphasis on applied learning activities in academic classes; and increasing communication, cooperation, and coordination among vocational and academic teachers in order to provide the extra instructional help and support that students need to succeed.

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Third, the Consortium is based on the assumption that closing the gap between vocational and academic education will increase student motivation for learning. Today, too many high school students pursue a vocational concentration that allows them to choose "general" academic courses that do not provide adequate preparation for either employment or some form of postsecondary education. It is a fact that more students would complete higher-level English, mathematics, and science courses if completing such courses were expected of them. Today we insist that our "brightest" students—those in the college preparatory curriculum—pursue a well-defined, structured program of study with few options. However, the students most in need of structure—students in the general and vocational curricula—are provided with the least. The result is that these students wander through a "cafeteria" curriculum of endless choices in which too many spend too much time at the dessert table.

The Consortium addresses this problem by forging academic and vocational courses into a more rigorous and challenging program of study aimed at the dual purpose of preparing a greater number of youth more adequately for meaningful employment and for success in postsecondary education. Based on our collective efforts to date, we now know what must be done if we are to raise significantly the basic competencies of vocational students over the next five years.

- **The Challenge is Complex and Difficult, But Not Impossible to Achieve.**

  "We" represent our most difficult challenge. Our views and biases concerning what we expect of certain students and our views about how the secondary school should operate represent our biggest obstacles. Information is available today on what we should be doing to raise the basic competencies of vocational students. What we need to do can be found in the exemplary practices that are underway in the network of pilot sites. However, adapting and molding these individual exemplary practices into a coherent, redesigned and refocused total secondary school experience remains the challenge. If we could collect all of the positive practices currently in the 36 pilot sites and implement them across all sites, the goals of this Consortium would be easily accomplished.

- **As a Group, Vocational Completers from the Pilot Sites Performed Better Than Expected in Reading and Mathematics.**

  The National Assessment of Educational Progress evaluation of almost 3,100 vocational completers from 34 pilot sites in the spring of 1988 indicated that the SREB vocational completers read at a level significantly higher than do vocational completers nationally. Further, the SREB vocational completers read as well as students in public and private schools nationally who complete the general curriculum. The mathematics achievement of vocational completers from the 34 sites is significantly higher than that of vocational students nationwide and higher than the achievements of students nationally who complete the general curriculum. While the science achievement of vocational completers from the SREB sites equals the science achievement of vocational students nationally, it is significantly below the science achievement of students from the general curriculum. The poor showing of vocational completers in science is a serious concern to the political and educational leaders in the region since economic competitiveness depends on an adult workforce with high levels of science and technological literacy.

  It appears that the basic skills high school graduation exams now required in most SREB states have resulted in vocational and academic teachers rallying together to improve the reading and mathematics achievement of some students taking "vocational" courses. The problem, however, is that these minimal scores remain far below the literacy levels now required in today's workplace.

Black vocational completers at the SREB pilot sites scored significantly above the average for all black students nationwide in reading and mathematics and at the national average for all black students in science. White vocational completers at the sites had average scores significantly below the average for all white students in the nation in each subject assessed. Consistent with national data, white vocational completers at the sites scored significantly higher than black completers in all three subject areas. However, the gaps between the scores of black and white vocational completers at the sites are about half of those between the scores of all black and all white students in the nation.

- **Students Learn Significantly More Communications, Mathematics, and Science Competencies in Some Schools Than They Do in Others.**

  The differences in achievement among pilot sites are enormous and it appears that most of the differences can be attributed to high school experiences and the level of expectations established for students by the schools.

- **Expectations Affect Performance.**

  One factor that distinguished low-achieving sites from high-achieving sites was whether or not students had been given homework assignments, which is one way to measure what schools expect of students. Of the 3,100 vocational completers, 26 percent indicated they never had any homework assignments during high school. The percentages ranged from a low of just over 4 percent at one site to a high of 51 percent at another site. Students from the first site, where 96 percent of them reported having homework, had among the highest reading, math, and science scores. At the site where half the students reported that they were never assigned homework, racial and socioeconomic backgrounds were similar to those of students at the first site, yet reading, math, and science scores were significantly below the Consortium average—and, in fact, were among the lowest at any pilot site. This latter site has the potential to do much better. Assigning homework alone will not solve the problem—homework must be meaningful, it must be examined, and it must be part of an overall instructional plan; however, homework is one way in which the school conveys a level of expectations to its students. Students who never read, write, or work math problems outside of school will not develop these competencies to the degree as students who are required to do so.

- **Students Had Higher Reading Scores in Sites Where Academic and Vocational Teachers Require Them to "Read for Learning."**

  Reading achievement scores ranged from a low of 47 at one pilot site to a high of 57 at two pilot sites. High reading scores appear to be associated with four practices.
  (1) More students at the higher-achieving sites were enrolled in higher-level English courses. At one of the higher-achieving pilot sites 29 percent of the vocational completers were enrolled in the college preparatory English course. This compares to the Consortium average of 17 percent and a low of 3 percent at one pilot site.
  (2) English teachers at high-achieving sites had higher expectations for students. For example, English teachers at one high scoring site required every student—regardless of what English course they were taking—to read at least one book each month starting in grade 9. Students were also required to write at least one paragraph each week.
  (3) Vocational teachers at sites with reading achievement scores required vocational students to read for technical learning. At one site where the students had particularly high reading scores, over 70 percent of the vocational completers reported their vocational teachers often stressed reading as a part of the vocational instructional process. The Con-

sortium average was 46 percent; at one site only 30 percent of the vocational completers reported that their vocational teachers often stressed reading.
(4) students had significantly higher reading scores at sites where vocational and academic teachers had been prepared and had used "reading for learning" as an instructional strategy. Reading is advanced by learning to read and comprehend difficult materials. Vocational and academic teachers at many sites report they do not know how to instruct students in reading for learning.

- **Students Have Higher Math Scores If They Take Higher-Level Courses and If They Are Required To Use Math Skills in New and Meaningful Situations.**

  The mathematics achievement of students is associated with expectations, types of courses taken, and by the emphasis given to mathematics by the vocational teacher. For example, the percentage of vocational completers who had completed algebra I ranged from a high of 95 percent at one site to a low of 36 percent at another; the Consortium average was 69 percent. The percentage of students who had completed algebra II ranged from a high of 50 percent to a low of 13 percent; the Consortium average was 35 percent. Completing an algebra course resulted in an average achievement gain of 12 points—more than four times the gain from a general math course.

  Students who took a mathematics course their senior year had significantly higher math achievement than those who did not. Across the Consortium 42 percent of the seniors took a math course. More students from high-achieving sites reported that their vocational teachers often stressed mathematics. Fifty-six percent of the vocational completers from all sites said their vocational teachers often stressed mathematics. This percentage ranged from a low of 36 percent in one site to a high of over 70 percent at another.

  Again, the achievement of students with common socioeconomic and racial backgrounds varied from site to site. We could significantly advance the mathematics achievement of vocational completers if students at all sites completed algebra I, 75 percent completed algebra II or geometry, and 90 percent of vocational teachers often stressed mathematics.

- **Students Have Higher Science Scores If They Enroll in Lab Science Courses and if Learning Progresses From the Concrete to the Abstract.**

  There were two sites in which science scores of vocational completers approximated the average science scores for all high school graduates nationally. Two things were different about these two sites. First, the percentage of vocational completers who had taken either chemistry or physics exceeded the Consortium average of 27 percent and 11 percent, respectively. Second, in both settings science had been taught with a strong laboratory and "hands on" emphasis.

  Only twenty-seven percent of the vocational completers reported that their vocational teachers often stressed science. Few vocational teachers in pilot sites stress the connection between technology and science.

- **The Courses Students Choose in High School Are Far More Important in Advancing Their Achievement Than Are the Number of Credits They Accrue in a Given Subject Field.**

  It appears that a mathematics course labeled general, basic, or remedial increases a student's NAEP mathematics achievement on the average by less than 3 points. In contrast, a course labeled pre-algebra would appear to increase students' achievement by 9 points; an algebra I course by 12 points; and a geometry course by 13 points. Students who choose a

vocational field with a heavy emphasis on mathematics, and one in which the teacher often stresses mathematics, appear to gain 9 points in their mathematics achievement.

Except for a few sites, the current science curriculum for many vocational students is a vast wasteland. On the average, students take 2.5 credits in science, compared to 3 credits in mathematics. Only 27 percent of the vocational completers have taken chemistry and only 11 percent have taken physics, yet these two physical sciences are the underpinnings for many vocational fields. Courses labeled "general science" appear to produce very little gain in the science achievement of these students. Science instruction for many vocational students seldom includes participating in a lab activity and can be fairly accurately described as textbook centered, row seat instruction with emphasis on memorizing terms.

Progression in learning is usually from the concrete to the abstract. Vocational students can learn advanced mathematics and science concepts if they can use them through tangible and direct experiences. With experience, they grow in their ability to understand abstract concepts, manipulate symbols, reason logically and generalize. The skills develop slowly, however, and most people depend on concrete examples to understand new ideas throughout life. Vocational studies can be most effective in providing secondary youth with relevant concrete learning experiences. Students taking vocational courses are often denied an opportunity to grasp abstractions through tangible experiences because their instruction is focused on either remembering and reciting technical terms that they do not understand or on watered down academic content. As a result, secondary—academic and vocational—teachers often underestimate the ability of these students to handle abstractions.

People learn to do well only what they practice doing. Linking academic and vocational studies enables students to apply mathematics and science ideas in novel situations which can enhance their mastery of academic content. If students practice only calculating answers to drill exercises or unrealistic "word problems," then that is all they are likely to learn. Similarly, students cannot learn to think critically, analyze information, communicate scientific and technical ideas, make logical arguments, or work as part of a team unless they are asked and encouraged to do those things over and over in a context that makes sense to them.

- **Students Learn More When Their Vocational Teachers Stress the Academics.**

Not only were there tremendous differences among achievement levels of students from different sites, but there were marked differences in achievement of students from different vocational fields. On the average, students from business, health, marketing and technical fields scored higher than the Consortium average in all three subject areas; students from agriculture, home economics, and trade and industrial education scored below the Consortium average.

According to what students reported, mathematics was stressed more in the technical and trade and industrial fields than in agriculture, business, health, and home economics. Reading was given more emphasis by business, health, and home economics teachers than by agriculture, trade and industrial, and marketing educators. Finally, 58 percent of the students from health occupations, reported that their health teachers often stressed science. Forty percent of the agriculture completers said their teachers stressed science.

The point is that students who reported that their vocational teachers often stressed reading, mathematics, and science skills had significantly higher average scores in all three subject areas than those students who reported no such emphasis.

- **At Least One-Half of Those Students Who Pursue Vocational Studies Say Too Little Is Expected of Them in High School.**

  More than three-quarters of the 3,100 vocational completers tested in the spring of 1988 said that if they could repeat their high school career, they would pursue a more rigorous program of studies. In interviews with 150 students at 11 sites during the on-site visits this past year, more than one-half the students said not enough was expected of them by either their vocational or academic teachers. Only 45 percent of the vocational completers participating in the National Assessment reported that they had been encouraged to take more math and science courses. A higher percent of the students in low-scoring sites reported that high expectations had not been established for them by either their teachers or their schools. On the average, 37 percent of the students said the courses they had taken in high school had not been challenging, with as many as 65 percent saying this in some sites.

  Levels of expectations differ widely from site to site for students with similar abilities. It appears that students in many of the sites are allowed to select those courses in which they are the most comfortable rather than being pushed and encouraged to choose those courses that would stretch them to their maximum potential.

- **Higher Achieving Pilot Sites Have More Students Pursuing a Coherent and Rigorous Sequence of Vocational and Academic Courses.**

  Most schools in the Consortium need to rethink how they assist students to plan their program of study. A planned program requiring students to complete related higher-level academic courses along with their vocational studies serves as a motivational device for increasing the percentages of vocational students taking higher-level academic courses.

  School counselors have a crucial role in assisting students to develop a unified and challenging program of study. Approximately half of the vocational completers had visited with a school counselor on their program prior to the 11th grade, yet these students had significantly lower mathematics, reading, and science scores than students who reported no counseling. It appears that in many schools if a student elects to take vocational studies, no one, including the vocational teachers, pays much attention to the kind of academic sequence he or she takes. However, in a few sites, it seems students had higher achievement when counselors started working with students as early as the 8th grade, administering assessments of interest and aptitude, and used these results to help students plan a rigorous program of academic and vocational study leading to the dual outcome of employment and postsecondary education.

  Improvement in basic competency achievement depends on changing students' view of what is expected of them and assisting them to plan a program of vocational and academic studies that is more coherent and rigorous. To achieve this end some school sites will have to reduce access to low-level academic courses.

- **Many of the Vocational Students Can Master Higher-Level Mathematics, Communications, and Science Concepts When These Principles Are Taught Through an Applied or Functional Instructional Strategy.**

  Excitement exists in those sites where the teachers have used the applied mathematics and applied physics materials developed by the Center for Occupational Research and Development (CORD) in Waco, Texas. Students who normally would not have taken advanced mathematics or science classes have been able to pursue successfully these higher-level courses. Basic competency achievement will increase if more vocational students enroll in either college preparatory courses or in more rigorous applied

courses that are designed to teach the content from the college preparatory courses through a functional process.

- **There is a Lack of Consensus Among All Sites and Within Some Individual Sites on the Purpose of Vocational Education at the Secondary Level.**

  Only about half of the vocational teachers, general and vocational administrators, non-vocational teachers, and counselors at the pilot sites see the purpose of secondary vocational education as a learning system—one designed to enhance students' overall basic competencies and technical knowledge and to produce an individual with the ability to adapt, adjust, and succeed in either a work setting or a postsecondary institution. However, the other 50 percent have a very different perception of secondary vocational education. About one-third of them believe that the purpose of vocational education is to prepare youth only for entry-level jobs. To another third, the primary purpose is to provide exploratory experiences that teach youth about work. The remainder see secondary vocational education as a place for those who cannot make it in the general and academic curriculum. It is our belief that a consensus must exist among personnel in all pilot sites that the purpose of secondary vocational education is to prepare youth with the ability to continue to learn in either a work or educational setting.

- **Closing the Academic and Vocational Gap Requires Academic and Vocational Teachers to Communicate and Cooperate More.**

  We know from the personnel survey conducted during the fall of 1988 that vocational and academic teachers seldom talk to each other. We have learned that it is possible to build trust, understanding, and to eliminate old prejudices between these two groups of faculty when they are given an opportunity to meet frequently. Learning more about what goes on—or should go on—in each others' classrooms will lead to teachers working together to help students advance their knowledge of—and achievement in—mathematics, science, and communications. We cannot expect students to see the relationship between academic disciplines and problems in a vocational context unless their teachers do.

  We have learned that change is greater in pilot sites where someone has been assigned the responsibility to keep communications open and continuous among all those participating in the effort. This task is more difficult in pilot sites where more than one school setting is involved.

  We have learned that more change is occurring in sites where the superintendent has taken a personal interest in the Consortium intiative. Sites where the superintendent takes the time to check on progress and encourages innovation are doing more.

  The building principal is crucial. The principals in Oklahoma have taken extra steps to get academic teachers to implement more rigorous and applied academic courses. Principals in Randolph County, West Virginia, took the lead in revamping math courses, which resulted in the elimination of the general math courses from the high school curriculum.

  At Norview High School in Norfolk, Virginia, the principal has worked with faculty to enroll students into higher level academic courses.

  In other sites principals have participated with teachers in in-service activities to improve reading for learning throughout the entire curriculum.

  When a clear signal has been sent by the school superintendent and school board, there is greater openness to change by all—principals, counselors, and teachers. Without question, more progress in closing the vocational and academic gap is being made in sites where academic and vocational teachers have been allowed and encouraged to work and plan

together. Yet, nearly three-fourths (71 percent) of pilot site administrators reported that they never meet with vocational teachers to plan instructional activities.

State leadership also is crucial to advancing Consortium goals. Where the state pilot site coordinator has taken time to work with them, pilot sites are making more progress.

Change is often painful, difficult, and slow. The redesign and refocus of the secondary curriculum into a more rigorous program of vocational and academic studies is not a task that will be easily achieved. It is a task that will require our energy and ingenuity.

- **We Have Learned a Few Additional Things About Teachers and How To Raise the Basic Competencies Achievement of Students.**

  It appears that vocational teachers devote as much time to reinforcing reading and writing in their classrooms as do non-vocational teachers. The question is whether that is enough time. This may be something that all sites need to reexamine. If reading and writing do not become tools for learning, students will neither advance in these basic competencies, nor will they acquire needed academic and technical knowledge.

  Vocational teachers assign as many one-page written assignments as do non-vocational teachers, but one-third of the vocational and non-vocational teachers do not ask essay questions on examinations. Thus, many of the students in these sites are never required to demonstrate in a free response fashion that they comprehend and can apply what they have been taught.

  Over 60 percent of the vocational teachers reported that it was extremely important to reinforce mathematics and reading, but only 30 percent reported that it was important to reinforce science. Only one in five vocational teachers reported that they could reinforce science and writing well; only one in four said they could reinforce reading well; and only one in three said they could reinforce mathematics well. This suggests that many vocational teachers may need further preparation for reinforcing the academics, since you can no more reinforce what you don't know than you can return from some place you have never been.

In summary, if one could take the best practices from each site and implement them in all sites, dramatic improvements could be made in the basic competencies of vocational completers. What we have learned suggests that higher expectations, more rigorous course content, and the reinforcement of the academics in the vocational curriculum can have a positive impact on increasing the basic competency achievement of vocational students. That will occur only when everyone recognizes that all share a common goal in the educational development of those students who take vocational courses; develops a new openness to change; and becomes willing to think differently about how to structure and design a more coherent and challenging total program.

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